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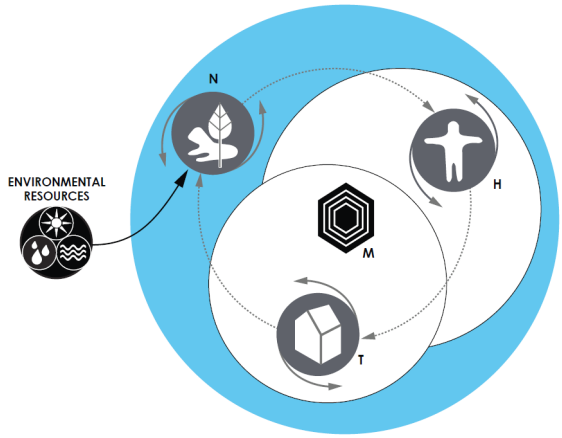

We live in a fabricated world. Under human impact, the planet has been transformed to such a degree that geologists propose a new name for the age that begins with the Industrial Revolution: after the Pleistocene and the Holocene, the Anthropocene. Luis Fernandez-Galiano

The course draws on systems ecology and the history and philosophy of technology to examine the complex task of environmental building design. Rethinking ecological design at the beginning of the twenty-first century means reconsidering the strong claims made about ecology and technology—utopian and dystopian—through the twentieth century, as the impacts of technology on eco-systems were encountered.

The term **ecology** was first coined in the late 19th century to describe the complex role of the environment in the evolution of species, and has grown to become the branch of biology concerned with the organization and dynamics of the entire bio-geosphere. Since the 1930s, the reach of ecological thinking has been extended dramatically by two developments, increased awareness of the environmental effect of human actions and the refinement of systems theory.

Environmental building design is a process of discovery, of deciding what to work on, before it ever becomes a matter of design. The course begins with urban self-organization, using cities to explore the principles of systems ecology, developed by HT Odum and his colleagues. Considering the theories of self-organization, natural selection, maximum power, and energy transformation hierarchies will provide a scientific basis for the examination of energy and resource flows in buildings. The next section applies those concepts to buildings as shelters, and the final section to the products and processes that occupy buildings, from working, eating, sleeping, playing, and so on. Course work will include weekly readings, in-class exercises, and a project in 3 stages. Weekly class meetings will be divided between lectures, discussion, exercises, and student presentations.

The class will be taught in person with provisions for online access for students who are delayed or in quarantine. See Canvas.upenn.edu for more details.

Grading and Evaluation. Attendance at all class meetings is mandatory. Multiple unexcused absences will lead to a reduction in grade or failure. Please notify the instructor in advance if you know that you will not attend class for any reason. No texting or email during class sessions and laptops are only to be used for course work. Evaluation of the work will be based on school grading policy, specifically 20% for participation, discussions, and in-class exercises, 30% for part 1 of the project, 30% for part 2, and 20% for part 3.

Students are expected to be independently familiar with the Code of Academic Integrity (www.upenn.edu/academicintegrity/ai_codeofacademicintegrity). Violations of the Code are most serious and will be handled in a manner that fully represents the extent of the Code and that befits the seriousness of its violation.

Required book:

Braham, William W. 2015. *Architecture and Systems Ecology: Thermodynamic Principles for Environmental Building Design.* Routledge.

Suggested books:

Odum, Howard T. 2007. *Environment, Power, and Society for the Twenty-First Century: The Hierarchy of Energy*. New York: Columbia University Press.

Meadows, Donella. *2008. Thinking in Systems: A Primer*. White River Junction: Chelsea Green.

Course materials are available at Canvas.UPenn.edu

Instructor: Dr. William W. Braham, FAIA
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Weekly readings and exercises are explained in more detail in Canvas.upenn.edu. The ">" indicates a required reading.

	Topic | Readings	In Class	Project	T,8:30-11:30
1	**Ecology, Technology, Design**	**W1: Pick a City**		8/29/2023
	[1] Site: Urban Land	**W1: What is an Environmental Building?**		
		Design Energy Code: ASHRAE Standard 90.1		
		Building Energy Rating: Energy Star		
		Environment: USGBC LEED		
		Climate: Architecture 2030		
		Design: Passive House		
		Ecology: Living Building Challenge		
		Philadelphia Climate Action Playbook		
2	**Thermodynamics and Urban Self-Organization**	**W2: Urban Assets and Resource Flows**		9/5/2023
>	Johnson, 2001, Emergence			
>	Schelling Model: Parable of Polygons			
	Doxiadis, "Ekistics, …Human Settlements."			
3	**Land and Location**	**W3: Urban Location and Self-Organization**		9/12/2023
>	Braham, "Spatial concentration of urban assets"			
>	Meadows, Systems Lens & Systems Basics, 1-34			
	Brown, "Areal Empower Density"			
4	**Urban Transitions**	**W4: Renewable City**		9/19/2023
>	Abel, "Emergy, Sociocultural Hierarchy, and Cultural Evolution"			
>	Meadows et al, "Overshoot"			
	Braham, "Visualizing a Change of Energy Regimes"			
	Braham et al, "The New Chautauqua Game"			
5	**Cities, Regions, Economies**	**W5: Diagram City-Region**		9/26/2023
>	Ascione, "Environmental driving forces of urban growth"			
>	Law of Rent			
	Odum, "Energy Systems Diagramming" *Modeling*			
	Brown et al, "Emergy Synthesis"			
6	**Site: Discuss city diagrams**	**W6: BioClimatic Simulation - Exercise**		10/3/2023
	Shelter: What do Buildings Do?			
	[2] Shelter: House			
7	**Bioclimatic Design**	**W7: BioClimatic Simulation - Project**		10/10/2023
>	Fernandez-Galiano, "Architecture Discovers Fire"			
>	Banham, "Environmental Management"			
	Braham, ASE, 61-67			
8	**Construction, Materials, and Products**	**W8: How much does your house weigh?**		10/17/2023
>	Odum, "Material Circulation… Building Construction"			
>	Brand, "Shearing Layers"			
>	SLA, "Changing Speeds"			
	Braham, ASE, 70-80			

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9	**Concentrated Power & Hierachy of Flows**	**W9: House Diagrams, Concentrated Energy**	10/24/2023
>	McCullough, "To Island," Downtime on the Microgrid		
>	Odum, EPS7, "Empower Basis for Society"		
	Lambert & Hall, ËROI & Quality of Life"		
	Smil, "Power Density Primer"		
	MacKay, "Sustainable Energy," 22-112, 140-156		
	Braham, ASE, 139-153		
10	**Shelter Project Review - Discussion**	**W10: Activitiy Selection Exercise**	10/31/2023
	[3] Setting: Activities		
	Braham, Benghi, "Varieties of building E[m]ergy Intensity."		
11	**Setting: Material Flows and Waste**	**W11: House Diagrams, Water, Waste, and Stuff**	11/7/2023
>	McDonough, "Waste equals Food"		
>	Buenfil, Emergy Evaluation of Water, 1-17		
	Buenfil, "Results," Emergy Evaluation of Water, 78-129		
	Illich, "Fertile Night Soil of Paris"		
	Braham, ASE, 125-139		
	Braham, ASE, 99-118		
12	**Setting: Information and Currency**	**W12: Activity Diagrams**	11/14/2023
>	Daly, "Fundamental Vision" Ch. 2, 4		
>	Bataille, "General Economy"		
	Braham, ASE, 147-152		
	Braham, Introduction, Rethinking Technology		
13	**No Class: Thanksgiving Shift**		11/21/2023
14	**Design in Complex, Self-Organizing Systems**	**W14: Activity Interventions**	11/28/2023
>	Meadows et al, "Leverage Points"		
>	Braham, Temptations of Survivalism		
	Hardin, Tragedy of the Commons		
	Meadows et al, "Dynamics of Growth"		
15	**Final Presentation & Discussion**		12/5/2023
	Final Submission		TBD

Course guide and schedule may be subject to change

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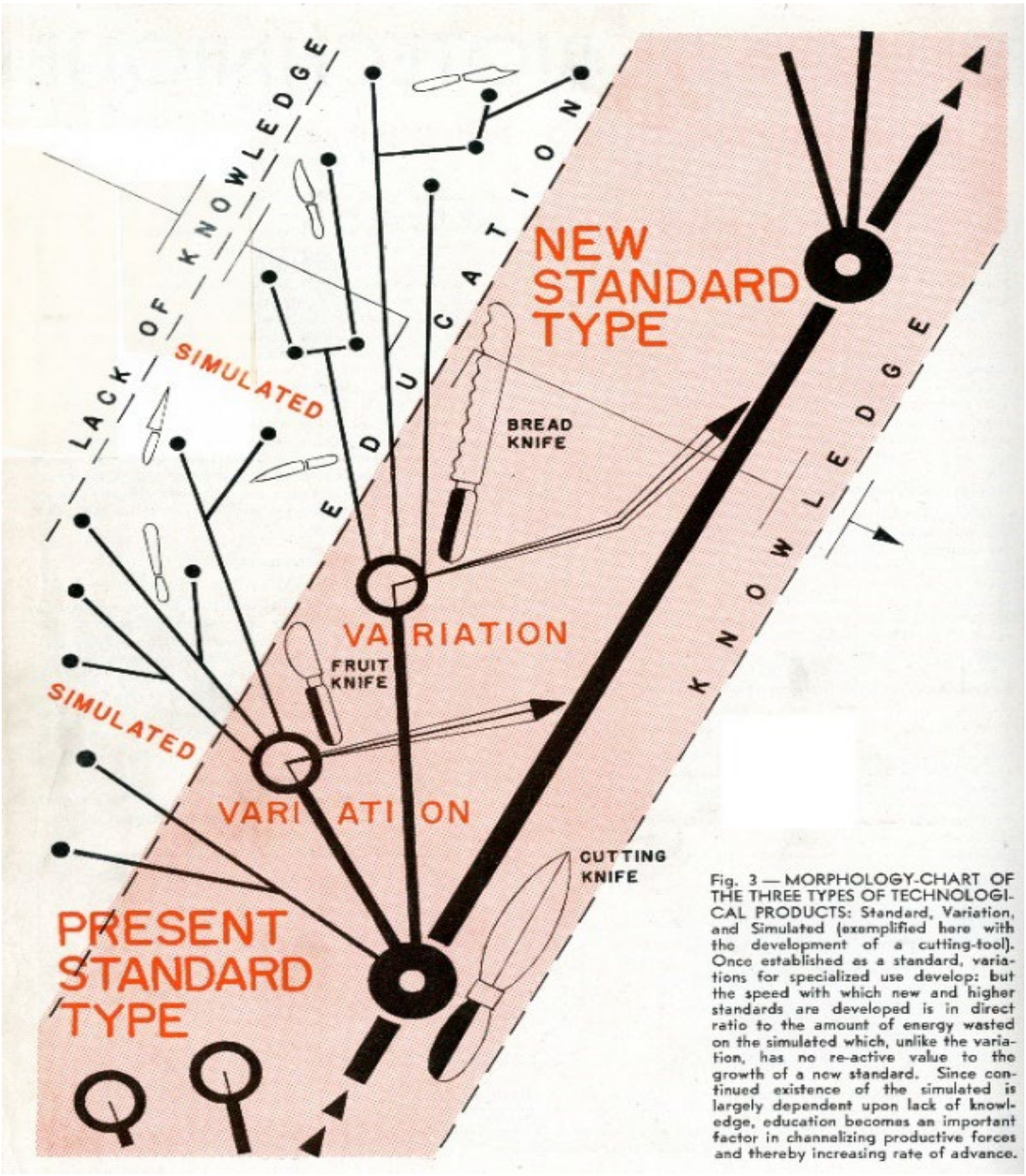

Fig. 3 — MORPHOLOGY-CHART OF THE THREE TYPES OF TECHNOLOGICAL PRODUCTS: Standard, Variation, and Simulated (exemplified here with the development of a cutting-tool). Once established as a standard, variations for specialized use develop: but the speed with which new and higher standards are developed is in direct ratio to the amount of energy wasted on the simulated which, unlike the variation, has no re-active value to the growth of a new standard. Since continued existence of the simulated is largely dependent upon lack of knowledge, education becomes an important factor in channelizing productive forces and thereby increasing rate of advance.